

REMARKS

By this Amendment, Claims 1, 3, 5, 11, 16 and 20 have been amended. Claims 1-20 are pending. The specification has been amended to change the formula " $C_xH_yF_z$ " to " $C_xF_yH_z$ " for consistency. Reconsideration of the September 30, 2003 Official Action is respectfully requested.

1. Objection to Claims

The Official Action objects to Claims 3, 9 and 20. As suggested in the Official Action, Claim 3 has been amended to change the formula " $C_xH_yF_z$ " to " $C_xF_yH_z$ ", and Claim 20 has been amended to correct an obvious typographical error. Claim 9 recites alternative pressure ranges that can be used in embodiments of the claimed method.

Withdrawal of the objections is respectfully requested.

2. Rejection Under 35 U.S.C. §112, Second Paragraph

The Official Action rejects Claim 16 under 35 U.S.C. §112, second paragraph, asserting that the meaning of the recitation "the cleaning gas includes O_2 , Cl_2 and/or BCl_3 " is unclear.

For clarification, Claim 16 has been amended to recite that "the cleaning gas includes O_2 , Cl_2/O_2 , BCl_3/O_2 or $BCl_3 + Cl_2/O_2$." Support for this amendment is provided at page 4, lines 6-7, of the specification. The amendment to Claim 16 do not narrow its scope. Withdrawal of the rejection is respectfully requested.

3. Rejection of Claims 11, 13, 14 and 20 Under 35 U.S.C. §102(e)

The Official Action rejects Claims 11, 13, 14 and 20 under 35 U.S.C. §102(e) over U.S. Patent No. 6,383,942 to Narita et al. ("Narita"). The reasons for the rejection are stated at page 3 of the Official Action. The rejection is respectfully traversed.

Claim 11 recites a method of reducing aluminum fluoride deposits formed in a plasma etch reactor during processing of a semiconductor substrate, comprising, inter alia, "etching a layer on the semiconductor substrate during a main etch by energizing the etching gas into a plasma state, the etching gas used during the main etch including $C_xF_yH_z$ wherein

$x \geq 1$, $y \geq 1$, $z \geq 0$, the main etch resulting in buildup of aluminum fluoride deposits ... within the plasma etch reactor; and etching the layer on the semiconductor substrate during an overetch etch by energizing the etching gas into a plasma state, the etching gas used during the overetch including BCl_3 " (Emphasis added.) That is, the claimed method comprises etching the same layer by both a main etch and an overetch etch. The main etch uses an etching gas including $\text{C}_x\text{F}_y\text{H}_z$ and the overetch etch uses a different etching gas including BCl_3 . The main etch results in the buildup of aluminum fluoride deposits within the plasma etch reactor. During the overetch etch, undissociated BCl_3 reduces the buildup of aluminum fluoride deposits on the interior chamber surfaces. Narita fails to disclose or suggest the method recited in Claim 11.

Narita discloses a dry etching method. In Narita's method, metal wiring (stacked film) 13 is formed on an insulation film 12. The stacked film 13 includes a metal film 13a and a thin film 13b formed on the metal film 13a. The metal film 13a includes aluminum as the principal ingredient. The thin film 13b has a single layer structure of metal (Ti or W) or a metal compound (titanium nitride or tungsten silicide) (column 5, lines 3-26). The thin film 13b is dry-etched using a first etching gas (column 5, lines 54-55), and the metal film 13a is etched using a second etching gas having a different composition than the first etching gas (column 6, lines 1-4). An exemplary first etching gas composition is a mixture of Cl_2 , Ar and CF_4 gases (column 7, lines 4-6). The second etching gas contains Cl and BCl_3 gases (column 7, lines 33-34).

Narita fails to disclose etching the same layer by a main etch using an etching gas including $\text{C}_x\text{F}_y\text{H}_z$ and an overetch etch using a different etching gas including BCl_3 . Narita discloses that the mixture of chlorine and fluorine in the first etching gas is selected to cause aluminum fluoride to be deposited on metal film 13a, thereby preventing the metal film from being etched with the first etching gas (column 6, lines 42-55). The second etching gas is then used to etch the metal film 13a. Narita does not disclose or suggest etching the metal

film 13a by a main etch using an etching gas including $C_xF_yH_z$ and an overetch etch using a different etching gas including BCl_3 , as recited in Claim 11. Moreover, Narita fails to disclose or suggest a method comprising a main etch that results in buildup of aluminum fluoride deposits on interior chamber surfaces exposed to the plasma within the plasma etch reactor, and an overetch etch in which undissociated BCl_3 reduces the buildup of such aluminum fluoride deposits on the interior chamber surfaces, as recited in Claim 11. Accordingly, the method recited in Claim 11 is patentable over Narita.

Claims 12 and 13 depend from Claim 11 and thus also are patentable over Narita for at least the same reasons as those for Claim 11. Therefore, withdrawal of the rejection is respectfully requested.

4. Rejection of Claims 1, 2 and 8 Under 35 U.S.C. §102(a)

The Official Action rejects Claims 1, 2 and 8 under 35 U.S.C. §102(a) over U.S. Patent No. 6,168,153 to Kitsunai et al. ("Kitsunai"). The reasons for the rejection are stated at page 3 of the Official Action. The rejection is respectfully traversed.

Claim 1, as amended, recites a method of removing aluminum fluoride deposits from a plasma etch reactor, which comprises "plasma etching an aluminum layer on a semiconductor wafer in a plasma etch reactor, the plasma etching resulting in aluminum fluoride deposits in the plasma etch reactor; supplying a cleaning gas to the plasma etch reactor, the cleaning gas comprising at least BCl_3 ; and cleaning the aluminum fluoride deposits from the plasma etch reactor by energizing the cleaning gas into a plasma state such that the BCl_3 gas is dissociated and undissociated BCl_3 reacts with aluminum fluoride deposits in the plasma etch reactor" (emphasis added). Kitsunai fails to disclose or suggest the method recited in Claim 1.

Kitsunai discloses a plasma treatment method. Kitsunai discloses an embodiment that comprises etching SiO_2 films. During etching of such SiO_2 films in a chamber containing alumina, aluminum fluoride deposits can form by reaction of fluorine with the alumina (paragraph bridging columns 4-5). Kitsunai discloses adding to an etching process a step of

removing etching reaction products and a step of removing chemical compounds of the apparatus inside component materials and etching gases (column 5, lines 15-25). Kitsunai discloses a cleaning operation that uses a mixture of BCl_3 and Cl_2 and another cleaning operation using O_2 and SF_6 . Kitsunai does not disclose or suggest, however, that this embodiment includes the combination of features recited in Claim 1, including the feature of "plasma etching an aluminum layer on a semiconductor wafer in a plasma etch reactor, the plasma etching resulting in aluminum fluoride deposits in the plasma etch reactor," as recited in Claim 1.

Kitsunai discloses another embodiment in which aluminum wires are etched (column 6, lines 27-57). In this embodiment, a first layer 20 made of aluminum is etched using Cl_2 gas, which can cause Al or AlCl_x to be attached and adhered to apparatus inner walls. A second layer of TiW_2O is etched using an SF_6 plasma, which may result in Ti or W stacked and adhered to apparatus inner walls and/or components. Kitsunai does not disclose or suggest that aluminum fluoride deposits form in a plasma etch reactor as a result of plasma etching an aluminum layer on a semiconductor wafer in a plasma etch reactor. Accordingly, the method recited in Claim 1 is patentable over Kitsunai.

Claims 2 and 8 depend from Claim 1 and thus also are patentable over Kitsunai for at least the same reasons that Claim 1 is patentable. Therefore, withdrawal of the rejection is respectfully requested.

5. Rejection of Claims 12, 15 and 18 Under 35 U.S.C. §103(a)

The Official Action rejects Claims 12, 15 and 18 under 35 U.S.C. §103(a) over Narita. The reasons for the rejection are stated at page 4 of the Official Action. The rejection is respectfully traversed.

As explained above, Narita fails to disclose or suggest the method recited in Claim 11. Accordingly, dependent Claims 12, 15 and 18 are also patentable over Narita for at least the same reasons as those for Claim 11. Therefore, withdrawal of the rejection is respectfully requested.

6. Rejection of Claim 16 Under 35 U.S.C. §103(a)

The Official Action rejects Claim 16 under 35 U.S.C. §103(a) over Narita in view of U.S. Patent No. 6,420,274 to Baker et al. ("Baker"). The reasons for the rejection are stated at pages 4-5 of the Official Action. The rejection is respectfully traversed.

As explained above, Narita fails to disclose or suggest the method recited in Claim 11.

It is acknowledged in the Official Action that Narita does not disclose or suggest a cleaning gas composition comprising O₂, Cl₂ and/or BCl₃, as recited in Claim 16. It is asserted in the Official Action that Baker discloses a cleaning gas composition comprising O₂ and Cl₂. However, Baker does not suggest modifying Narita's method to achieve a method of reducing aluminum fluoride deposits formed in a plasma etch reactor during processing of a semiconductor substrate, comprising, inter alia, "etching a layer on the semiconductor substrate during a main etch by energizing the etching gas into a plasma state, the etching gas used during the main etch including C_xF_yH_z wherein x ≥ 1, y ≥ 1, z ≥ 0, the main etch resulting in buildup of aluminum fluoride deposits ... within the plasma etch reactor; and etching the layer on the semiconductor substrate during an overetch etch by energizing the etching gas into a plasma state, the etching gas used during the overetch including BCl₃" (Emphasis added.) Thus, the method recited in Claim 16 also is patentable over the combination of Narita and Baker for at least the same reasons as those for Claim 11.

Therefore, withdrawal of the rejection is respectfully requested.

7. Rejection of Claims 17 and 19 Under 35 U.S.C. §103(a)

The Official Action rejects Claims 17 and 19 under 35 U.S.C. §103(a) over Narita in view of Kitsunai and further in view of U.S. Patent No. 6,313,048 to Hineman et al. ("Hineman"). The reasons for the rejection are stated at page 5 of the Official Action. The rejection is respectfully traversed.

Claims 17 and 19 depend from Claim 11. It is acknowledged in the Official Action that Narita does not disclose or suggest a cleaning gas composition comprising Cl_2 and BCl_3 , or the use the of CHF_3 as a component of an etching gas during a main etching step. It is asserted in the Official Action that Hineman discloses etching with CHF_3 . However, Kitsunai and Hineman do not suggest modifying Narita's method to achieve a method of reducing aluminum fluoride deposits formed in a plasma etch reactor during processing of a semiconductor substrate, as recited in Claim 11, which comprises, inter alia, "etching a layer on the semiconductor substrate during a main etch by energizing the etching gas into a plasma state, the etching gas used during the main etch including $\text{C}_x\text{F}_y\text{H}_z$ wherein $x \geq 1$, $y \geq 1$, $z \geq 0$, the main etch resulting in buildup of aluminum fluoride deposits ... within the plasma etch reactor; and etching the layer on the semiconductor substrate during an overetch etch by energizing the etching gas into a plasma state, the etching gas used during the overetch including BCl_3 " (Emphasis added.) Thus, the subject matter recited in Claims 17 and 19 also is patentable over the combination of Narita, Kitsunai and Baker for at least the same reasons as those for Claim 11.

Therefore, withdrawal of the rejection is respectfully requested.

8. Rejection of Claim 9 Under 35 U.S.C. §103(a)

The Official Action rejects Claim 9 under 35 U.S.C. §103(a) over Kitsunai. The reasons for the rejection are stated at page 5 of the Official Action. The rejection is respectfully traversed.

As explained above, Kitsunai fails to suggest the method recited in Claim 1. Accordingly, the method recited in dependent Claim 9 also is patentable over Kitsunai for at least the same reasons as those for Claim 1. Therefore, withdrawal of the rejection is respectfully requested.

9. Rejection of Claims 3-6 Under 35 U.S.C. §103(a)

The Official Action rejects Claims 3-6 under 35 U.S.C. §103(a) over Kitsunai in view of Narita. The reasons for the rejection are stated at page 6 of the Official Action. The rejection is respectfully traversed.

It is acknowledged in the Official Action that Kitsunai does not disclose cleaning a chamber following an etchant process using a first etchant composition of $\text{CF}_4/\text{Cl}_2/\text{BCl}_3$. It is asserted in the Official Action that Narita discloses an etching process using a first etchant composition of $\text{CF}_4/\text{Cl}_2/\text{BCl}_3$ and a second etching composition of Cl_2/BCl_3 . However, the combination of Kitsunai and Narita does not suggest a method of removing aluminum fluoride deposits from a plasma etch reactor, which comprises “plasma etching an aluminum layer on a semiconductor wafer in a plasma etch reactor, the plasma etching resulting in aluminum fluoride deposits in the plasma etch reactor; supplying a cleaning gas to the plasma etch reactor, the cleaning gas comprising at least BCl_3 ; and cleaning the aluminum fluoride deposits from the plasma etch reactor by energizing the cleaning gas into a plasma state such that the BCl_3 gas is dissociated and undissociated BCl_3 reacts with aluminum fluoride deposits in the plasma etch reactor” (emphasis added). Accordingly, the method recited in dependent Claims 3-6 is patentable over Kitsunai and Narita for at least the same reasons as those for Claim 1.

Therefore, withdrawal of the rejection is respectfully requested.

10. Rejection of Claim 7 Under 35 U.S.C. §103(a)

The Official Action rejects Claim 7 under 35 U.S.C. §103(a) over Kitsunai in view of Baker. The reasons for the rejection are stated at page 6 of the Official Action. The rejection is respectfully traversed.

As explained above, Kitsunai fails to disclose or suggest the method recited in Claim 1. It is acknowledged in the Official Action that Kitsunai fails to disclose the conditioning of a plasma chamber after cleaning the chamber. It is asserted in the Official Action that Baker discloses conditioning a plasma chamber after cleaning the chamber. However, Baker fails

to suggest modifying Kitsunai's method to achieve the method recited in Claim 1. Thus, the method recited in dependent Claim 7 is patentable over Kitsunai and Baker for at least the same reasons as those for Claim 1.

Therefore, withdrawal of the rejection is respectfully requested.

For the foregoing reasons, withdrawal of the objection and rejections and prompt allowance of the application are respectfully requested.

Respectfully submitted,

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